Manuscript: **Automated Avalanche Hazard Indication for Southeast Alaska**

Authors: Elizabeth Fischer, Gabriel J. Wolken, Yves Bühler, Marc Christen, and Rick Lader

Journal: NHESS / EGUsphere https://doi.org/**10.5194/egusphere-2026-1345**

Recommendation: **Major Revision**

1. Does the paper address relevant scientific and/or technical questions within the scope of NHESS?

Assessment: **Yes — clearly.**

The manuscript fits well within the scope of *Natural Hazards and Earth System Sciences*. It deals directly with:

- snow-avalanche hazard;
- numerical modelling of mass movements;
- hazard-indication mapping;
- climate-change effects on natural hazards;
- implications for infrastructure and land-use planning;
- hazard assessment in a data-sparse environment.

The central scientific problem—how to generate regional avalanche hazard information where conventional observations and site-specific assessments are unavailable—is both scientifically relevant and technically important.

The focus on climate-related changes in avalanche hazard also aligns particularly well with the interdisciplinary scope of NHESS.

No major concern under this criterion.

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2. Does the paper present new data and/or novel concepts, ideas, tools, methods or results?

Assessment: **Yes, particularly in terms of application, scale and resulting datasets.**

The fundamental components of the methodology are not themselves entirely novel. RAMMS: LSHIM, automated PRA delineation and regional hazard-indication mapping have been developed previously, especially by Bühler et al. (2022 – cum bibl.).

However, the manuscript presents substantial novelty in the following areas:

- application of the methodology to Southeast Alaska - a particularly data-sparse, maritime/sub-Arctic environment;
- integration of historical reanalysis and future dynamically downscaled climate information;
- regional-scale implementation involving more than 3.5 million avalanche simulations;
- development of a regional dataset where no comparable systematic hazard-indication product previously existed;
- comparison of modelled avalanche hazard extent between historical and future climatic periods.

This work shows **moderate methodological novelty but high applied and regional novelty.** The manuscript should articulate this distinction more explicitly.

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3. Are these up to international standards?

Assessment: **Partly; substantial improvement is required.**

The general modelling framework is consistent with established international avalanche-modelling practice, particularly through the use of RAMMS::LSHIM and established PRA methodologies.

However, several aspects currently fall short of the level of methodological robustness normally expected for quantitative international hazard assessment:

- the treatment of 30- and 300-year scenarios is not probabilistically robust;
- uncertainty is discussed but not quantified;
- validation is predominantly qualitative;
- climate uncertainty is represented by only one model/scenario combination;
- vegetation thresholds are partly heuristic;
- effective information resolution is occasionally overstated;
- terms such as *risk* are used where the analysis actually represents *hazard* indication or *susceptibility*.

Thus, the study framework is internationally relevant, but the current implementation and interpretation require strengthening before the results can fully satisfy international standards of quantitative hazard assessment.

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4. Are the scientific methods and assumptions valid and outlined clearly?

Assessment: **Generally understandable, but only partly validated and not always sufficiently justified.**

The overall workflow is described clearly enough to understand its main structure: DEM → forest mask → snowfall forcing → PRA generation → release-depth calculation → RAMMS simulation → avalanche extent/intensity mapping. However, several assumptions require more rigorous justification.

4.1 Snowfall downscaling

The original WRF information is at approximately 4 km resolution. It is remapped to 10 m, Gaussian-smoothed, and corrected using elevation. This produces a raster with 10 m spacing, but not meteorological information physically resolved at 10 m. The paper must state this distinction clearly throughout.

4.2 Lapse-rate assumption

The final implementation effectively uses a constant snowfall lapse rate of 0.0923 mm m^{-1} throughout Southeast Alaska. This is a strong regional simplification that requires stronger empirical support and sensitivity testing.

4.3 Release depth

Release depth is calculated as: $d_0 = d \cos\theta$ without the more complete corrections used in the SLF standard procedure. Given the direct influence of release depth on avalanche volume and runout, this assumption should be subject to sensitivity analysis.

4.4 Vegetation assumptions

The treatment of Deciduous, Mixed and Evergreen Forest and the use of a 30% vegetation threshold for filtering low-elevation avalanches are insufficiently justified quantitatively.

4.5 Recurrence intervals

The relationship between maximum 30-year snowfall and the assigned 30-/300-year avalanche scenarios is not sufficiently rigorous and represents one of the manuscript's most important methodological weaknesses.

This criterion requires major revision.

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5. Are the results sufficient to support the interpretations and the conclusions?

Assessment: **Only partly.**

The results support several **qualitative** conclusions reasonably well:

- avalanche hazard is spatially extensive in Southeast Alaska;
- vegetation classification strongly affects low-elevation PRA and runout modelling;
- projected warming may reduce hazard at lower elevations;
- colder high-elevation northern areas may respond differently;
- the automated framework is useful for regional screening.

However, some **quantitative interpretations are too strong**.

For example, Figure 20 interprets a 10% change in affected area within a 100 × 100 m grid cell as approximately a **10 m retreat of maximum avalanche runout**.

Given the combined uncertainty in:

- 4 km atmospheric forcing;
- snowfall downscaling;
- land-cover data;
- PRA geometry;
- release depth;
- friction parameters;
- wind redistribution;
- model formulation;

This interpretation gives a misleading impression of metre-scale predictive precision.

Likewise, statements about future hazard should be framed as outcomes from the **specific CCSM4–RCP8.5 simulation considered**, rather than as deterministic predictions of future conditions.

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6. Does the author reach substantial conclusions?

Assessment: **Yes, but some conclusions should be reformulated more cautiously.**

The manuscript reaches important conclusions regarding:

- spatial variability of avalanche hazard;
- implications of climatic warming;
- regional differences in future snowfall extremes;
- the usefulness of automated hazard-indication mapping in data-poor regions.

These are substantive scientific conclusions.

However, the statements that the outputs provide an "*immediately useful basis for hazard-informed infrastructure planning and land-use decision-making*" and a "*defensible regional baseline*" are somewhat stronger than warranted by the present validation.

It is recommended to describe the outputs primarily as: "*a regional screening and prioritisation tool identifying areas requiring detailed site-specific hazard assessment*".

The maps should not be presented as substitutes for detailed engineering-scale avalanche hazard zoning.

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7. Is the description of the data, methods, experiments, calculations and results sufficiently complete and accurate to allow reproduction?

Assessment: **Partly, but not yet sufficiently.**

The broad workflow is reproducible conceptually, but full computational reproducibility is limited.

The manuscript states that the complete workflow requires multiple operating systems and proprietary software, including ArcGIS, eCognition and IDL. The Code Availability section indicates that only portions of the code are publicly available.

For adequate traceability and reproducibility, the authors should provide:

exact version of RAMMS::LSHIM;

- exact friction parameterisation for each PRA class;
- complete PRA decision-tree settings;
- all filtering thresholds;
- exact software versions;
- WRF variable names and preprocessing steps;
- kernel implementation and boundary treatment;
- all scripts required to reproduce the snowfall downscaling;
- forest-mask generation rules;
- release-depth input tables;
- post-processing thresholds;
- configuration files;
- a workflow diagram;
- ideally, representative complete input/output examples.

The distinction between **results availability** and **workflow reproducibility** should also be made clearer.

This criterion requires major revision.

8. Does the title clearly and unambiguously reflect the contents of the paper?

Assessment: **Mostly yes.**

The title: *Automated Avalanche Hazard Indication for Southeast Alaska* is concise and generally accurate. However, the manuscript also contains a significant climate-change component. A more informative title might be: "*Automated Avalanche Hazard Indication Mapping for Southeast Alaska under Historical and Future Climate Conditions"* or: "*Automated Regional Avalanche Hazard Indication Mapping for Southeast Alaska under Present and Future Climate Conditions".*

That said, the current title is acceptable and does not require mandatory change.

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9. Does the abstract provide a concise, complete and unambiguous summary?

Assessment: **Generally yes, but some wording should be moderated.**

The abstract effectively summarises:

- the motivation;
- the data-scarcity problem;
- the modelling framework;
- the historical/future comparison;
- the number of simulations;
- the main regional climate response.

However, several aspects need improvement.

Recommended revisions: The abstract should explicitly state that:

- the future projection is based on a **single CCSM4–RCP8.5 realisation**;
- the products are **hazard-indication maps**, not probabilistic hazard maps or risk maps;
- the results should be interpreted as regional screening information.

The phrase "*first region-wide, climate-informed assessment of avalanche susceptibility*" is generally appropriate, but the abstract should avoid implying site-specific predictive accuracy.

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10. Are the title and abstract pertinent and understandable to a wide and diversified audience?

Assessment: **Yes, with minor improvements.**

The title is accessible. The abstract is understandable to readers familiar with natural-hazard science, but terms such as:

- PRA;
- RAMMS::LSHIM;
- dynamically downscaled climate projections;

may not be immediately understandable to the broader NHESS readership.

The abstract would benefit from reducing specialised modelling terminology slightly and briefly explaining RAMMS's function rather than merely naming the model.

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11. Are mathematical formulae, symbols, abbreviations and units correctly defined and used?

Assessment: **Mostly, but several problems require correction.**

The manuscript does not contain an excessive number of equations, and therefore a dedicated notation appendix is not necessary. However, several technical issues remain.

11.1 Snow-depth units

The manuscript reports typical snow depths around Juneau as approximately "0.7 m^2 and 1.2 m^2". These should presumably be **m**, not m^2.

11.2 Velocity threshold

The avalanche extent criterion appears in the text as velocity "at least 1 m", whereas the intended unit is presumably: $1 \mathrm{~m} \mathrm{~s}^{-1}$. This should be checked systematically.

11.3 Lapse-rate units

The manuscript alternates between:

- m km^{-1};
- mm m^{-1}.

These are dimensionally equivalent in this context, but the chosen unit should be standardised.

11.4 "Snowfall" versus "snow accumulation/depth"

These terms are occasionally used interchangeably. Snowfall amount, snow-water equivalent, settled snow depth and accumulated snow depth are not equivalent quantities.

11.5 Formula interpretation

Equation (1), deriving the lapse rate from spatial gradients, should include a clearer explanation of:

- sign convention;
- physical interpretation;
- treatment of flat terrain;
- numerical handling where $|\nabla H|$ approaches zero.

Moderate revision required.

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12. Is the size, quality and readability of each figure adequate?

Assessment: **Generally good, but several figures and captions require correction and improved interpretability.**

The maps are mostly useful, and the Juneau/Valdez/Cordova comparisons are particularly informative. However, several problems exist.

Figure 8 - The caption contains inconsistent historical and future periods. This must be corrected.

Figure 11 - The caption refers to “maximum height, maximum pressure and maximum depth”, whereas the plotted variables appear to be height, velocity and pressure.

Figure 14 - The caption apparently describes both low- and high-pressure areas as blue.

Figures 18–20 - These figures give a visual impression of quantitative precision that exceeds the confidence supported by the input data.

The captions should explicitly state: *The mapped values represent modelled hazard-indication extent rather than probabilistic avalanche risk.* Figure 20 should not imply an effective positional precision of approximately 10 m.

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13. Does the author give proper credit to previous work and clearly identify the original contribution?

Assessment: **Generally yes, with some important exceptions.**

The key methodological antecedents are properly acknowledged, especially:

- Bühler et al. (2013);
- Bühler (2018);
- Bühler et al. (2022);
- Christen et al. (2010);
- Sykes et al. (2022).

The manuscript makes clear that it is **adapting an existing automated hazard-indication methodology**, rather than presenting RAMMS or automated PRA delineation as entirely new. However, the authors should more explicitly distinguish between:

Existing methodology

- RAMMS dynamics modelling;
- PRA delineation;
- Swiss-style hazard-indication workflows.

Original contribution

- adaptation to Southeast Alaska;
- alternative snowfall forcing;
- treatment of Alaska land-cover constraints;
- climate-change application;
- regional computation and resulting dataset.

This distinction would strengthen the novelty statement.

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14. Are the number and quality of references appropriate?

Assessment: **Mostly yes, but the bibliography should be strengthened in several areas.**

The principal avalanche-modelling literature is appropriately represented. However, additional literature is needed on:

- uncertainty and sensitivity analysis in avalanche modelling;
- extreme-value estimation of snowfall;
- return-period estimation;
- climate-model uncertainty propagation;
- forest ecology of Southeast Alaska;
- possibly more recent work on avalanche response to climate change.

The bibliography is therefore adequate in quantity but somewhat uneven in thematic coverage.

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15. Are the references accessible by fellow scientists?

Assessment: **Mostly yes.**

Most journal references have DOIs and are readily accessible. Several important supporting sources are technical reports, including:

- TetraTech (2022);
- WSL Institute (2011);
- Fesler and Fredson (2000);
- Mears et al. (1992).

These may be less readily accessible internationally. Where such grey literature is essential to validation, the authors should provide persistent public links or archived versions whenever possible. The data reference to Wolken et al. (2026) is particularly important and should be verified to ensure long-term public accessibility.

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16. Is the overall presentation well structured, clear and understandable?

Assessment: **The broad structure is sound, but it needs substantial editorial improvement.**

The overall progression is logical: Introduction → data/methods → validation → regional results → limitations → conclusions.

However, the manuscript would benefit from clearer separation between:

- Results;
- Validation;
- Discussion;
- Limitations.

At present, interpretation and results are sometimes intermixed.

The manuscript also contains a non-trivial number of typographical and grammatical errors.

Examples include:

- “Thane Red” instead of **Thane Road**;
- “estimaation”;
- “within a call” instead of **within a cell**;
- “interprested”;
- “comptuer”;
- inconsistent use of NLCD/NCLD;
- “deliminate” instead of **delineate**.

A comprehensive English-language and technical copy-edit is necessary.

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17. Is the length of the paper adequate?

Assessment: **Generally adequate.**

At approximately 34 pages including references and numerous figures, the manuscript is not excessively long given:

- the large study area;
- methodological complexity;
- extensive validation examples;
- climate-change component.

It is not recommended to shorten it.

However, some descriptive passages concerning local examples could potentially be condensed if additional space is required for the more important methodological additions requested in this review, particularly:

- sensitivity analysis;
- uncertainty quantification;
- quantitative validation;
- recurrence-interval clarification.

Thus, the overall length is appropriate, but the content balance could be improved.

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18. Are there parts that need clarification, reduction, addition, combination or elimination?

Assessment: **Yes — several substantial modifications are recommended.**

Clarify

The following require clarification:

- derivation of the 30- and 300-year scenarios;
- relationship between PRA size and recurrence interval;
- meaning of “maximum possible three-day snowfall”;
- statistical basis of the snowfall lapse rate;
- treatment of Mixed Forest;
- rationale for the 300 m elevation threshold;
- rationale for the 30% land-cover threshold;
- interpretation of the future climate scenario.

Add

The manuscript would benefit substantially from:

A sensitivity-analysis section

At minimum, testing:

$$d_0 \times 0.8;\ d_0;\ d_0 \times 1.2$$

and alternative forest thresholds.

Quantitative validation

For example:

- intersection-over-union;
- false-positive area;
- false-negative area;
- runout-distance error;
- spatial overlap statistics.

Uncertainty discussion

Preferably with at least partial quantification.

Workflow schematic

A single figure showing the entire workflow would greatly improve clarity.

Reduce or modify

Reduce use of the term ***risk***. Remove or substantially revise interpretations implying metre-scale predictive precision. The expression **"*maximum possible snowfall*"** should be removed.

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19. Is the technical language precise and understandable by fellow scientists?

Assessment: **Mostly understandable, but not consistently precise.**

The technical language is generally accessible to avalanche and natural-hazard scientists. However, several terms require more rigorous usage. "Hazard", "susceptibility", and especially "risk" are used too interchangeably. This is one of the most important conceptual issues, although it should also be relatively straightforward to correct.

The modelling framework essentially estimates: release susceptibility + modelled avalanche propagation/intensity under prescribed scenarios. It does not, in a strict sense, estimate risk because it does not systematically incorporate exposure, vulnerability, and expected loss. Even hazard in the probabilistic sense is only partially represented, because it does not estimate event frequency using a robust probabilistic framework. Nevertheless, Section 3.2 refers to areas as being "*currently susceptible to avalanche hazards*" and then repeatedly shifts to the term "*avalanche risk*". The same issue arises in Figure 19, where changes in the proportion of land affected by simulated avalanche extents are described explicitly as changes in "*avalanche risk*". This is more than a terminological issue. A change in the area reached by simulated avalanches does not in itself constitute a change in risk.

Most importantly:

Risk - should not be used as a synonym for avalanche-affected area.

Hazard - should be distinguished from hazard indication and probabilistic hazard.

Return period - should only be used where the corresponding probability is adequately defined.

Resolution - The distinction between:

- raster grid spacing;
- effective source-data resolution;
- predictive positional accuracy;

must be made explicit.

Maximum snowfall - "*Maximum possible*" should be replaced by "*maximum simulated during the considered 30-year period*".

Technical precision would improve considerably if these terms were revised systematically. The authors should use terminology such as: *avalanche hazard indication*, *modelled avalanche-affected area*, *potential hazard extent*, or *avalanche susceptibility*. Moreover, reserve risk for analyses that explicitly incorporate exposure and vulnerability.

The term "*buildable zone*" is also overly normative. Elevation below 40 m does not necessarily imply that land is suitable for development. It would be better to use "*low-elevation zone* or *development-relevant lowland zone* instead.

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20. Is the English language of good quality, fluent, simple and easy to understand?

Assessment: **Understandable, but not yet publication-ready.**

The manuscript is generally understandable, but the English requires systematic editing.

There are:

- typographical errors;
- grammatical inconsistencies;
- awkward expressions;
- duplicated words;
- inconsistent terminology;
- caption errors;
- occasional informal wording.

Examples noted include:

- "*our simulations finds*";
- "*estimaation*";
- "*interpreted*";
- "*comptuer*";
- "*light greet*";
- inconsistent singular/plural agreement;
- several malformed date ranges.

A professional or careful native-level language edit is recommended before acceptance.

This issue alone would not warrant Major Revision, but it should be addressed alongside the scientific revisions.

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21. Is the amount and quality of supplementary material appropriate?

Assessment: **Currently insufficient for a study of this computational complexity.**

The manuscript does not appear to provide supplementary material commensurate with the workflow's complexity. For a study involving more than 3.5 million simulations and a multi-stage preprocessing pipeline, supplementary material should ideally include:

- complete RAMMS parameter tables;
- PRA thresholds;
- land-cover decision rules;
- release-depth settings;
- numerical workflow;
- model versions;
- representative configuration files;
- sensitivity analyses;
- validation metrics;
- additional maps;
- possibly tabulated regional statistics;
- exact climate-processing methodology.

The current Code and Data Availability statements are useful but do not fully replace detailed supplementary methodological documentation.

It is therefore recommended to provide a substantial **Supplementary Information** document.

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22. Principal scientific issues requiring Major Revision

Based on the 21 criteria above, the following issues are essential before acceptance.

Recurrence intervals and extreme-event methodology

The paper labels scenarios as corresponding to 30- and 300-year recurrence intervals, yet the forcing relies substantially on maxima derived from 30-year climate periods. The authors themselves recognise that such values may underestimate 100- and 300-year extremes and that Extreme Value Theory would provide a more rigorous framework.

The relationship between 30-year maximum snowfall Moreover, 30-/300-year avalanche scenarios must therefore be explained rigorously.

At minimum, the authors should distinguish T_{release} from T_{impact} because the recurrence interval associated with release conditions is not necessarily equivalent to the recurrence interval of avalanche impact at a given point.

If probabilistic recurrence intervals cannot be robustly estimated, the manuscript should use more qualitative terminology, such as frequent-type scenario and rare-type scenario, rather than implying precise 30- and 300-year probabilities.

Quantification of uncertainty

Uncertainty enters at every stage: Climate model → WRF downscaling → snowfall downscaling → PRA → d_0 → RAMMS → hazard extent. However, almost all simulations are deterministic.

The paper should include at least a representative sensitivity analysis. It is strongly recommended to vary:

Release depth: $0.8d_0$, $1.0d_0$, $1.2d_0$

Forest threshold: For example 20%, 30%, 40%, 50%

Snowfall lapse rate: At least a plausible lower and upper alternative.

RAMMS friction parameters: If computationally feasible, test representative parameter ranges on selected avalanche paths.

The purpose need not be a complete formal uncertainty propagation across all 3.5 million simulations. A representative sensitivity experiment would already substantially strengthen the manuscript.

Validation should be made more quantitative.

The current validation is useful but predominantly qualitative. The authors compare their outputs with previous assessments in Juneau and Valdez. Where digital polygons are available, it is recommended to calculate:

$$IoU = \frac{A_{\text{model}} \cap A_{\text{reference}}}{A_{\text{model}} \cup A_{\text{reference}}}$$

as well as:

Hit Rate
False Positive Rate
False Negative Rate

and, where possible:

$$\Delta L_{\text{runout}}$$

between modelled and reference runout.

Even a limited quantitative assessment for Juneau would represent an important methodological improvement. It is also recommended to rename the section: “***Evaluation against existing local hazard assessments*”** unless more rigorous quantitative validation is added.

Correct distinction between hazard, hazard indication and risk

This terminology should be revised throughout the manuscript. A useful conceptual hierarchy would be:

Susceptibility - where avalanches may initiate or propagate;
Hazard - probability and intensity of avalanche occurrence;
Exposure - people/assets within affected areas;
Vulnerability - expected degree of damage;

and therefore:

$$\text{Risk} = f(\text{hazard, exposure, vulnerability})$$

The current study does not systematically quantify the latter two components.

Consequently, most uses of **risk** should be replaced by:

- hazard-indication area;
- avalanche-affected area;
- avalanche susceptibility;
- potential hazard extent.

Interpretation of 4 km → 10 m downscaling.

This issue should be explained particularly carefully. The snowfall field is represented at 10 m after interpolation and terrain correction, but its fundamental meteorological information originates from kilometre-scale atmospheric modelling. Therefore:

$$10 \text{ m grid spacing} \neq 10 \text{ m meteorological resolution}$$

and certainly:

$$10 \text{ m grid spacing} \neq 10 \text{ m predictive accuracy.}$$

The interpretation in Figure 20 of a 10% grid-cell change as approximately 10 m of runout retreat should therefore be removed or strongly qualified.

Climate-scenario uncertainty

The projected changes represent one climate-model/scenario combination. The text should therefore avoid statements such as: "*avalanche hazard will decrease*" and instead use: "*the CCSM4–RCP8.5 simulation used in this study indicates a decrease in modelled avalanche hazard extent*…"

This modification is particularly important in the Abstract and Conclusions.

Vegetation treatment

The land-cover model is one of the largest potential sources of spatial uncertainty. The authors acknowledge misclassification problems in NLCD. Moreover, the 30 m NLCD data are resampled to 10 m, increasing raster sampling density but not the underlying land-cover information.

The sensitivity of hazard-indication results to:

- Mixed Forest treatment;
- Evergreen classification;
- the 30% threshold;
- the 300 m threshold;

should therefore be tested.

Release-depth treatment

The simplified release-depth formulation is understandable given data scarcity, but its impact on avalanche propagation must be demonstrated. Because avalanche volume scales approximately with release depth,

$$V \propto A_{\mathrm{PRA}}\, d_0,$$

uncertainty in $d_0$propagates directly into dynamic-model forcing. Release-depth sensitivity should therefore be treated as a core methodological issue rather than merely a limitation mentioned in the discussion.

Citation and bibliography assessment

The bibliography is generally scientifically sound, but it requires several corrections.

Védrine et al. (2022) - The reference itself is appropriate for avalanche–forest interaction. However, it is used to support the statement that Western Hemlock and Sitka Spruce dominate Southeast Alaska evergreen forests. That citation does not appear appropriate for regional forest composition. Replace it with a regional forest-ecology reference.

Sykes et al. (2022) - This is highly relevant to:

- PRA mapping;
- remote terrain;
- forested environments;
- data scarcity;
- validation.

It should play a considerably larger role in the Introduction and Methods.

White et al. (2024) - The reference is legitimate, but because it is primarily ecological, it should not be relied upon as the principal methodological justification for three-day snowfall forcing. A more directly methodological snow-avalanche reference would be preferable.

Additional work on uncertainty and sensitivity analysis in avalanche-dynamics modelling would be highly relevant, particularly given the very large number of deterministic simulations and the the modelling chain which propagates uncertainty through: climate model → downscaling → snowfall → PRA → release depth → RAMMS → hazard extent, without formally quantifying that propagation.

The manuscript would benefit from more specialised literature on extreme snowfall statistics and return levels, beyond the general reference to **Naveau et al. (2005)** which is insufficient on its own for a manuscript whose interpretation relies strongly on recurrence intervals. This is particularly important because the study explicitly uses 30- and 300-year scenarios.

Required editorial corrections

Several specific corrections should be made before publication:

- Correct the date ranges in Figure 8. The caption appears to state “*Historical (1981–1990) and Future (2051–2060)*”, whereas the panels and the rest of the manuscript use 1981–2010 and 2031–2060. This is almost certainly an error and should be corrected.
- Correct the snow depth units of m^2 to m where appropriate. Es. on p. 13, snow depths appear to be reported as “0.7 m^2 and 1.2 m^2”. The unit should presumably be m, not m^2.
- Figure 11 caption should correctly identify the plotted variables. The caption of Figure 11 states “*Maximum height, maximum pressure and maximum depth*”, whereas the axes show height, velocity, and pressure.
- Correct the colour description in Figure 14. In the Figure 14 caption, “*Blue areas indicate impact pressure <30 kPa and blue areas indicate pressure >30 kPa*”. One of these colours is evidently incorrect.
- “*light greet*” → “*light green*”;
- “*Thane Red*” → “*Thane Road*”;
- “*our simulations finds*” should be *our simulations find*.
- “*estimaation*” → “*estimation*”;
- “*within a call*” → “*within a cell*”;
- “*interpresteд*” → “*interpreted*”;
- “*comptuer*” → “*computer*”;
- “*ArCGIS*” → “*ArcGIS*”;
- *NCLD/NLCD* should be standardised;
- “*deliminate*” → “*delineate*”;
- The expression “*maximum 3-day snowfall, including settling*” requires clarification, because snowfall and settled snow accumulation/depth are not equivalent terms.
- The manuscript should use “*historical*”, “*historic*”, “*recent historic*”, and “*contemporary*” more consistently.
- Date ranges should be consistently formatted as 1981–2010 and 2031–2060 avoiding corrupted forms such as “2031-±2060”;
- Van Vuuren et al. DOI formatting should be corrected;
- The spelling and diacritics in “Bühler and Kuhne (2018)” should be checked and standardised to Bühler and Kühne, where appropriate.

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23. Summary evaluation table

NHESS criterion	**Assessment**
1. Relevance to NHESS	**Yes / Strong**
2. Novelty	**Yes / Mainly applied novelty**
3. International standard	**Partly — revision required**
4. Methods and assumptions	**Partly — major clarification required**
5. Results support conclusions	**Partly**
6. Substantial conclusions	**Yes, but some overstatement**
7. Reproducibility	**Incomplete**
8. Title	**Adequate**
9. Abstract	**Good, but requires qualification**
10. Accessibility of title/abstract	**Good**
11. Formulae, symbols, units	**Mostly adequate; several corrections required**
12. Figures	**Generally good; some important corrections**
13. Credit to previous work	**Generally appropriate**
14. References	**Adequate but should be expanded selectively**
15. Reference accessibility	**Mostly adequate**

NHESS criterion	Assessment
16. Structure and clarity	**Generally sound; editing required**
17. Length	**Appropriate**
18. Need for additions/clarification	**Substantial**
19. Technical language	**Generally good but conceptually inconsistent in places**
20. English	**Understandable but requires editing**
21. Supplementary material	**Insufficient for full reproducibility**

24. Final recommendation: MAJOR REVISION NEEDED

The manuscript addresses a highly relevant NHESS topic. It provides an original, large-scale application of automated avalanche hazard-indication modelling in a region where systematic avalanche hazard information is scarce. The principal scientific contribution is significant enough to justify further consideration for publication. However, the manuscript is not ready for acceptance because the current level of quantitative interpretation exceeds the robustness demonstrated by the methods.

The essential revisions are:

1. **clarify or reformulate the 30- and 300-year recurrence scenarios;**
2. **introduce a representative uncertainty/sensitivity analysis;**
3. **strengthen validation quantitatively where possible;**
4. **distinguish consistently between susceptibility, hazard indication, hazard and risk;**
5. **moderate claims of fine-scale spatial precision;**
6. **qualify future projections as results of the specific CCSM4–RCP8.5 realisation;**
7. **strengthen the treatment and uncertainty analysis of vegetation;**
8. **test sensitivity to release-depth assumptions;**
9. **improve reproducibility documentation and supplementary material;**
10. **perform comprehensive technical and English-language editing.**

Rejection of the manuscript is not recommended, because the study has **clear scientific value**, considerable computational investment, and **strong potential** as a regional-scale hazard-screening framework. At the same time, **Minor Revision would not be sufficient**, since several of the issues identified above require additional analysis rather than simple textual amendments. If the authors address these points satisfactorily, the revised manuscript could make a valuable contribution to the literature on **large-scale avalanche hazard-indication mapping, climate-sensitive natural hazards, and hazard assessment in data-sparse mountain environments**.